

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF SAFETY AND ENVIRONMENTAL ENFORCEMENT
GULF OF MEXICO REGION

ACCIDENT INVESTIGATION REPORT

For Public Release

1. OCCURRED

DATE: 18-SEP-2017 TIME: 1100 HOURS

2. OPERATOR: BP Exploration & Production Inc.

REPRESENTATIVE:
TELEPHONE:

CONTRACTOR:
REPRESENTATIVE:
TELEPHONE:

- STRUCTURAL DAMAGE
- CRANE
- OTHER LIFTING
- DAMAGED/DISABLED SAFETY SYS. See incident report
- INCIDENT >\$25K See incident report
- H2S/15MIN./20PPM
- REQUIRED MUSTER
- SHUTDOWN FROM GAS RELEASE
- OTHER loss of power

3. OPERATOR/CONTRACTOR REPRESENTATIVE/SUPERVISOR ON SITE AT TIME OF INCIDENT: 8. OPERATION:

4. LEASE:

AREA: MC LATITUDE:
BLOCK: 778 LONGITUDE:

5. PLATFORM: A(Thunder Horse)
RIG NAME:

- PRODUCTION
- DRILLING
- WORKOVER
- COMPLETION
- HELICOPTER
- MOTOR VESSEL
- PIPELINE SEGMENT NO.
- OTHER

6. ACTIVITY: EXPLORATION(POE)
 DEVELOPMENT/PRODUCTION (DOCD/POD)

7. TYPE:

- HISTORIC INJURY
 - REQUIRED EVACUATION
 - LTA (1-3 days)
 - LTA (>3 days)
 - RW/JT (1-3 days)
 - RW/JT (>3 days)
 - Other Injury

- FATALITY
- POLLUTION
- FIRE
- EXPLOSION

- LWC HISTORIC BLOWOUT
- UNDERGROUND
 - SURFACE
 - DEVERTER
 - SURFACE EQUIPMENT FAILURE OR PROCEDURES

COLLISION HISTORIC >\$25K <=\$25K

9. CAUSE:

- EQUIPMENT FAILURE
- HUMAN ERROR
- EXTERNAL DAMAGE
- SLIP/TRIP/FALL
- WEATHER RELATED
- LEAK
- UPSET H2O TREATING
- OVERBOARD DRILLING FLUID
- OTHER _____

- 10. WATER DEPTH: 6200 FT.
- 11. DISTANCE FROM SHORE: 66 MI.
- 12. WIND DIRECTION:
SPEED: M.P.H.
- 13. CURRENT DIRECTION:
SPEED: M.P.H.
- 14. SEA STATE: FT.
- 15. PICTURES TAKEN:
- 16. STATEMENT TAKEN:

17. INVESTIGATION FINDINGS:

On September 18, 2017, at 1100 hours a loss of power occurred at BP Exploration & Production Inc. MC 778-A Lease OCS-G 09868 (Thunder Horse) Platform. The Mississippi Canyon (MC) 778-A Facility experienced a full power failure including the emergency power on the facility. After the crew determined that the power could not be fully restored, the Offshore Installation Manager (OIM) decided to evacuate the personnel from the facility. Leading up to the blackout, the facility was undergoing construction on the Uninterruptible Power Supply A (UPS-A) to be replaced. The newly installed Uninterruptible Power Supply B (UPS-B) had been in-service for approximately 6 weeks before construction on UPS-A began. Over the course of seven days, the facility crew members performed troubleshooting in order to safely restore full power to the facility. It took approximately 24 hours to restore emergency power.

On September 17, 2017, at 2000 hours, the MC 778-A (Thunder Horse) UPS-B inverter failed but normal power continued to supply the Emergency Motor Control Center(s) (EMCC) when the UPS switched to Static Bypass Mode.

The following morning on September 18, 2017, at approximately 0700 hours, a BP electrician discovered the alarms on UPS-B during normal rounds. Another electrician was dispatched to respond and initiate troubleshooting of the alarms in the UPS-B room. Upon arrival in the UPS-B room, the electrician smelled an odor that led him to believe that some type of gas release was occurring in the battery room. After the electrician left the space briefly, he returned with a hand-held Altair 4x gas infrared (IR) detector and detected carbon monoxide inside battery room D2311, a room adjacent to the UPS-B control room, which holds the battery cells that support the UPS-B. The IR detector can detect hydrogen gas. However, the cross-sensitivity for hydrogen was unknown so the actual hydrogen concentration could not be determined. The electrician then notified the HSE Site Lead (SL) of the situation.

The SL arrived at the UPS-B room at approximately 0750 hours with a calibrated MSA Altair 5x IR Meter equipped with a wand and, with the battery room's door slightly cracked open, started taking readings at the door by inserting the gas detector probe through the crack at the breathing zone. The carbon monoxide (CO) reading was approximately 85-95 parts per million (ppm) in the breathing zone. The SL moved the probe towards the floor to check the CO reading and found it to be approximately 15-20 ppm. Subsequently the SL moved the probe to the top of the door and found a reading of approximately 125 ppm and climbing. There are three fixed hydrogen gas detectors in the battery room and none of them were detecting an abnormal amount of hydrogen.

The SL instructed the electricians to close the door. The emergency response team (ERT) discussed the aforementioned CO readings and retested to confirm the initial readings. For safety reasons, the SL decided to keep the door to the battery room closed and not allow anyone in until the ERT could figure out what was going on. The crew then discussed the ventilation supply and exhaust for the UPS-B room and after proceeded to the upper deck on the starboard side where the exhaust stacks are located. The crew checked the intake with portable gas detectors and found no issues with that area based on the location of the supply vents. The Electrician team checked multiple vents and was able to identify the exhaust vent location for the D2311 battery room that is located under the heliport. The Site Lead used a handheld gas detector with the probe to check the exhaust. The SL found the reading at 35-42 ppm and evacuated everyone in that area and red barricaded the area to take all safety precautions. The Site Lead asked the Instrumentation Tech (IT) to verify if the ventilation was correct. The IT inspected the airflow from the exterior to confirm the airflow to the battery room. The volume of air was not sufficient for the battery room's design and believed the low flow might not be enough to properly ventilate the battery room. At that point, the Offshore Installation Manager (OIM) decided to make an announcement to muster all personnel onboard since the UPS room was next to the

living quarters where personnel were sleeping as a precautionary measure. The OIM instructed the Marine crew to activate the general alarm. When the general alarm sounded, personnel mustered in a safe fashion to their designated muster areas. All personnel were accounted for and were informed of the situation onboard the facility.

Before disconnecting power supply to UPS-B batteries, the Wells Crew that was conducting well work closed and locked the blind shear rams in addition to two other barriers that were already in place.

Since UPS-B could not supply battery power due to its inverter failure, the ERT decided to preemptively start the Emergency Generator (EG) so that power would be maintained if the main power Turbine Generators (TG) were lost. In the process of syncing the frequency of power from the EG with the TGs, UPS-B's static bypass switch opened due to the frequencies being out of tolerance by just over one percent. BP was unaware that the UPS logic from the manufacturer had a syncing tolerance of one percent to protect the equipment's static switch as opposed to BP's normal set point of five percent. When the static bypass switch opened, the facility lost power, including the Vessel Management System (VMS) at 1118 hours, although emergency power was still available. The crew restored power to critical loads (including the VMS) by utilizing the "Maintenance Bypass" on UPS-B. When the VMS rebooted, an abandon platform sequence was initiated which shut down all main power TGs, tripped the EG to emergency bus breaker, and caused the production process to fail in a safe state. At this point the platform was experiencing a full electrical blackout.

After closing the EG to emergency bus breaker, power was again lost after approximately seven minutes. It was unknown at the time that the VMS was still initiating an abandon platform sequence. This cycle occurred two more times while crew was troubleshooting the blackout. Ultimately personnel were able to identify that the VMS was still initiating an abandon platform signal when rebooted which opened the breaker between the EG and the emergency bus. The ERT manually shut down the EG engine due to rising temperatures and started and loaded the Hurricane Generator to provide cooling for the EG engine. Personnel physically removed the VMS cable to the breaker that was causing it to open until they could reinstate power and clear the abandon platform signal. The crew then started the EG and closed the breaker to the emergency bus. Emergency power was reinstated with the EG now providing continuous power to the emergency bus at approximately 1930 hours.

While essential personnel were troubleshooting 265 out of 298 Personnel on-board (POB) were evacuated off the facility. Of the 265 evacuated, 123 POB were evacuated by helicopter to Houma, 84 people were evacuated by the Motor Vessel (MV) "Goliath", and 58 people were transferred by the MV "Fantasy Island" to the onshore base. The remaining 33 personnel onboard were considered the essential personnel to troubleshoot the blackout in order to safely restore power to the facility. All the Subsurface Controlled Surface Safety Valves (SCSSVs), Shutdown Valves (SDVs), and Boarding Shutdown Valves (BSDVs) closed per the approved Deepwater Operation Plan (DWOP) when the ESD on the facility was activated.

On the evening of September 18, 2017, the essential crew began preparation to start the Auxiliary Generators (AG), but before starting the AGs, smoke was detected in the UPS-A room at approximately 2140 hours. Emergency responders confirmed the presence of smoke but there was no fire. The source of the smoke was found to be one of two UPS systems for well operations, but the cause was unknown. After this issue the OIM decided to shut down the EG and evacuate the remaining personnel due to the uncertainty of being able to maintain habitability of the facility. All personnel were evacuated to the nearby Sedrill West Vela drill ship at 0130 hrs on September 19, 2017. The essential personnel returned to Thunder Horse later in the morning on September 19, 2017, to try to get the EG and AG running. They were successful in

restoring full power via the EG and AGs. At that point, the facility was inhabitable with full communications, fire and gas detection, HVAC, and fire water capability. The essential personnel remained on board through the night.

On September 20, 2017, additional personnel reboarded the platform (approximately 100 POB) with the primary focus to start the TGs to provide power for normal daily facility operations. Of the 5 turbine generators, 3-4 were normally running for daily platform operations with the fourth used for the waterflood injection system. However, the crew had to troubleshoot TGs 1, 3, and 4 due to having issues with running continuously. TGs 1-4 are diesel/gas powered while TG 5 starts and runs only on buyback gas. The POB was raised to approximately 114 people to aid in bringing up the TGs and eventually restoring production.

On September 21, 2017, the BP emergency response plan was approved by the USCG. The POB was raised to approximately 120-125 people to resume normal operations. Additional specialists were flown in to help troubleshoot the UPS issues.

On September 22, 2017, the BP Thunder Horse Operations Team continued to prepare the facility for warm up by injecting methanol into various points in the south field. The crew also started injecting methanol into the north field with no issues or obstructions. As the facility was getting to normal pressures and temperatures, the operations crew continued to test and actuate the SCSSVs on all the wells. The MC 822 Well No. 15 remained suspended until the ROV vessel could inspect the riser and subsea BOP.

On September 23 and 24, 2017, the UPS troubleshooting was completed and the electrical crew ran various tests to ensure UPS-B was fully functional.

On September 25, 2017, the facility's UPS-B system had no issues. All power was restored and the facility was preparing to return to normal POB to bring the facility full production back online.

On Tuesday, September 26, 2017, an on-site "BSEE Joint Investigation" was conducted at the BP Exploration MC 778-A Thunder Horse facility. The Investigation Team included the BSEE New Orleans District (NOD) Production Investigator, NOD Production Engineer, OII Investigator, Regional District Operations Support Engineer and Two USCG OCS Investigators. The BSEE & USCG investigation team interviewed key witnesses that were directly involved in troubleshooting the blackout incident. According to the witnesses, the crew went through a series of troubleshooting techniques to solve the problem in order to restore power to the facility in a safe manner.

Due to the complexity of the incident, and facility specific technical expertise needed, BSEE also relied on communication with, and documentation provided by, BP's subject matter experts.

18. LIST THE PROBABLE CAUSE(S) OF ACCIDENT:

- Lack of a formal mechanism to specify logic settings in the UPS system for use in this setup
- Inadequate communication of the UPS Replacement Project documentation

19. LIST THE CONTRIBUTING CAUSE(S) OF ACCIDENT:

- UPS-B inverter failed allowing batteries to overcharge
- Logic in the UPS system had too tight of power quality tolerance
- The power quality tolerance was not set to normal BP specifications
- VMS incorrectly backed-up thus maintaining abandon platform alarm state when rebooted

20. LIST THE ADDITIONAL INFORMATION:

21. PROPERTY DAMAGED:

NATURE OF DAMAGE:

ESTIMATED AMOUNT (TOTAL):

22. RECOMMENDATIONS TO PREVENT RECCURRANCE NARRATIVE:

1. Create or revise a "Black Start" procedure that includes the complete loss of power to the VMS and or PLC.
2. Consult with OEM to evaluate and make appropriate recommendations for UPS protective features.
3. Review the project engineering handover process for critical electrical systems to ensure personnel are properly trained to operate new equipment.
4. Create or review a platform evacuation procedure specifically prompted by a facility blackout. This evacuation procedure would be unique in that it is:
 - a. More deliberate than an abandonment due to a fire. For example, when a blackout occurs, the lifeboats would likely not be utilized.
 - b. More urgent than an evacuation due to a hurricane when flights and other transportation can be planned.
 - c. The procedure should consider a possibility of limited communications and resources due to the blackout.
5. Verify all necessary SEMS documentation (Emergency Response Plans, As-Built Electrical Drawings, Piping & Instrumentation Diagrams, Operating Procedures, etc.) are up-to-date and accessible in hard-copy format.
6. Review 30 CFR 250.842 - Any changes to the Facilities Electrical One-line drawing constitutes a Facility Safety System Permit Review.

7. Review the performance of critical ventilation systems relative to their basis of design and develop a strategy to address any findings from this review, including but not limited to future maintenance requirements.

23. POSSIBLE OCS VIOLATIONS RELATED TO ACCIDENT: **NO**

24. SPECIFY VIOLATIONS DIRECTLY OR INDIRECTLY CONTRIBUTING. NARRATIVE:

25. DATE OF ONSITE INVESTIGATION: 28. ACCIDENT INVESTIGATION
PANEL FORMED: **NO**

OCS REPORT:

26. INVESTIGATION TEAM MEMBERS:

29. DISTRICT SUPERVISOR:

Anthony Pizza / Pierre Laniox /

David Trocquet

APPROVED

DATE: **27-JUN-2018**